AGRIC.—1914—(520)

NYASALAND PROTECTORATE

Report of the DEPARTMENT of AGRICULTURE

For the year 1949

PART II

PRICE 2s. 6d.

14 JUL

1951:
PRINTED BY THE GOVERNMENT PRINTER, ZOMBA, NYASALAND

CONTENTS

	Page	Para.
Tung		
A. Production of Improved planting material	3	3–16
B. Cultural and Manurial Experiments	7	17–21
C. Diseases	9	22
Tea	9	23–61
General Crops		
A. Fertilizer Experiments	13	62–66
B. Miscellaneous Experiments	13	67–73
C. Tobacco	14	74–82
Entomological Division		
A. Crop pests	15	84–107
B. Storage of foodstuffs	16	108–112
Plant Pathology Division		
A. Survey of plant diseases	17	115–143
B. Investigations on Tung Diseases	21	144–153
C. General	23	154–156
Agricultural Chemistry	23	157–172

PART II.—EXPERIMENTAL WORK

The unprecedented drought in the early part of the year not only destroyed much of the annual crops under experiment but also resulted in staff being used on emergency food production duties. Consequently most Stations concerned with work on annual crops have little or no experimental work to report for the year. Work on perennial crops progressed as far as was possible according to plan.

TUNG

Tung Experimental Station. Cholo

Senior Agricultural Officer in charge : C. C. Webster

(Report received 20th April, 1950.)

2. Owing to the severe drought and the threat of famine, the European Staff of the Station were primarily occupied with duties connected with emergency food production during the first three months of the year and consequently experimental work on tung was somewhat reduced during this period. The drought itself did not appear to have any marked effect on the tung trees, and appreciable yield increases over the previous year were obtained in almost all experiments.

A.—Production of Improved Planting Material

Selection of Promising Mother Trees

3. Owing to the preoccupation with other duties early in the year it was impossible to extend the survey of seedling plantations in bearing or to select any more promising mother trees. The number of seedling trees covered by the survey therefore remains at last year's figure of rather more than 52,000, from which 749 outstanding trees have been provisionally selected for yield recording. Mention is made of the selection of a small number of mother trees from the legitimate seedling families on the Station in a later section.

Vegetative Propagation as Buddings

4. The testing of buddings, derived from the selected mother trees, in clone trials at the Station has continued, but as no further acreage was planted-up, the number under trial remains 100. Of these, the more recent clones, which are likely to be the most promising, having resulted from a wider and more thorough selection programme than the earlier ones, are either not yet in bearing or only just beginning to bear.

Buddings versus Seedlings

5. The superiority of buddings to unselected seedlings has now been clearly and definitely established as a result of several field experiments which have been running for eight years and in this section it is only necessary to mention the yields of one trial in which a comparison is made of : (*a*) unselected seedlings ; (*b*) selected seedlings raised from open pollinated seed taken from four good yielding mother trees ; (*c*) and (*d*) buddings from the same four mother trees on *montana* and *fordii* seedling roots respectively. A detailed account of the results obtained from this experiment up to 1948 was given in last year's Report, and the 1949 yields present the same picture. The mean yields per tree for 1949, and the mean total yields per tree for the six seasons 1944–1949 are shown in Table 1. On both sets of figures the buddings on *montana* stock are significantly better than any other treatments (P=0.01), having given almost double the yield of the selected seedlings and more than double that of the unselected seedlings. The buddings on *fordii* stock are better than either type of seedling on mean total yields (P=0.01) but only superior to unselected seedlings in 1949. There has never been any significant difference in yield between the selected and unselected seedlings. Table 2 gives the mean total yields per tree of the budded and seedling progenies of the different mother trees for the six seasons. All the clones on *montana* stock are significantly better (P=0.01) than the seedlings from the same mother tree and all except ZF9 are better than the seedling of any family. Similarly, the buddings on *fordii* stock are better than the corresponding seedling families except that of ZM8. The superiority of the ZM8 seedling progeny to buddings of ZM8 on *fordii* or of ZF9 on *montana* and to the other seedling progenies, is due to the fortuitous occurrence of an unusually small proportion of predominantly male trees in this small seedling family.

TABLE 1. YIELDS PER TREE, LBS. AIR DRY HULLED SEED

	Buddings		Seedlings		Sig. diff.	
	Montana stock	*Fordii* stock	Selected	Unselected	P= 0.05	P= 0.01
Yield, 1949, 8½ year old	28.4	19.5	15.8	12.2	5.58	7.72
Total yield 1944–1949	82.2	53.2	42.9	35.5	5.54	7.67

Table 2. Total Yields per Tree for Six Seasons, Lbs. Air dry Hulled Seed

Treatment	Clones				Significant diff.	
	ZM8	ZM13	ZH14	ZF9	P=0.05	P=0.05
Montana stock	85.1	98.0	86.5	58.8		
Fordii stock	47.3	52.9	60.2	52.4	7.26	9.70
Selected seedlings	66.6	41.0	31.8	32.5		

Clone Trials

6. The mean total yields from the clones of *montana* stock in the experiment just described are shown in the first line of Table 2 and the yields for 1948 and 1949 in Table 3. On mean total yields the results are the same as in previous years, *i.e.*, the clone ZM13 is better than all others and ZF9 is inferior to any other clone, but in 1949 ZM13 was only better than ZF9, and clone ZH14 gave an unexpectedly high yield. It will be seen that three of the clones have yielded over 1,600 lbs. of dry seed per acre at eight years old, which is very satisfactory.

Table 3. Yields, Lbs. Air dry Hulled Seed

Age	ZM8		ZM13		ZM14		ZF9		Sig. diff. per tree	
	per tree	per acre	per tree	per acre	per tree	per acre	per tree	per acre	P= 0.05	P= 0.01
7¼	23.6	1,322	26.9	1.506	20.6	1,154	13.9	778	4.92	6.47
8¼	29.1	1,630	31.8	1,781	32.8	1,837	19.8	1,109	5.23	6.87

7. A number of other clones are under trial in various field experiments but the only clones of equal age to the above are five which occur in the intercropping trial mentioned in para. 16. The average yields from all intercropping treatments of these clones for 1948 and 1949 and the mean total yields for 1944–1949 are given in Table 4. The two B-type clones, 14 and 10, have continued to give very much higher yields than the others, 10 being significantly better than 14. As in the trial described in paragraph 5, the clone ZF9 is significantly the worst, and there is no doubt that this is an inferior clone. It has never been recommended for planting and its occurrence on estates is limited to a few of the early buddings. Clone 10, which is the most consistent high yielder at the Station, has given over 2,000 lbs. of dry seed per acre at eight years old.

Table 4. Yields, Lbs. Air Dry Hulled Seed

	ZN24		ZM8		ZF9		14		10		Sig. diff. per tree	
	per tree	per acre	per tree	per acre	per tree	per acre	per tree	per acre	per tree	per acre	P= 0.05	P= 0.01
Age .. 7¼	13.9	778	15.6	874	11.2	627	24.6	1,378	25.7	1,439	2.31	3.04
Age .. 8¼	19.8	1,109	22.1	1,238	12.7	711	32.6	1,826	36.4	2,038	3.51	4.61
Total 1944–49	62.1		66.0		48.1		106.2		115.9		3.62	4.75

8. Examples of the yields of some of the younger clones are given in Tables 5, 6 and 7. Table 5 shows the yields from a 6×6 Latin Square clone trial, which are interesting because they contain another good B-type clone, ZO4, and the very promising clone ZC2A, which, although an A type, is rather precocious in bearing. Both of these clones have given good early yields in other trials. The yields of the two B-type clones, 14 and ZO4, are appreciably less than in 1948, and those of ZC2A slightly less. This may be due to the combined effect of bearing a very heavy crop for their age in 1948 and suffering an extremely dry season in 1949, but it is possible that it indicates a levelling off of the yield curves for the weaker B-clones. On the mean total yields the three clones 14, ZO4 and ZC2A have given better yields than the others. Table 6 shows two years' yields from five clones in another trial which are interesting as they contain an example of the weaker B-type clones, 4 and 9, which, although precocious in cropping, appear to be too lacking in vigour to exceed the three A-types in yield even in the early years. Yields in this trial were somewhat reduced by hail in 1948 and there are no significant differences between clones in either year. Table 7 is dealt with later, in paragraph 11.

TABLE 5. YIELDS, LBS. AIR DRY HULLED SEED

Year Age	ZM13	ZN24	ZC2A	B741	14	ZO4	Sig. diffs. P=0.05	Sig. diffs. P=0.01
1948 .. 5¼	22.9	17.5	32.2	21.3	34.3	30.1	5.30	7.33
1949 .. 6¼	26.7	22.9	31.1	19.0	24.1	25.7	not sig	not sig
Totals 1946–1949 ..	71.3	58.5	96.8	61.6	99.1	98.3	13.54	17.80
1949, lbs. per acre	1,495	1,282	1,742	1,064	1,350	4,139		

TABLE 6. YIELDS, LBS. AIR DRY HULLED SEED

	ZM8	B741	B742	4	9
1948 per tree (4¼)	4.5	6.0	5.7	5.9	5.8
1949 per tree (5¼)	14.1	15.9	19.3	14.0	11.7
1949 per acre	790	890	1,081	784	655

No significant differences

9. Early yields from other clones are available from several other trials and yields have continued to be recorded from observation plots of some of the older clones on Kamponji Estate. Neither of these are presented here ; the former because the records are as yet inadequate to provide information of value, the latter because yields have been seriously reduced by nitrogen deficiency in the past two seasons. A few clones can now be recommended with some confidence. These are : ZM13 and ZC2A of the A-type, and 14, 10 and ZO4 of the B-type. Amongst the younger clones there are a number of promising ones, but at least another two seasons' records are required before any statement can be made about them.

10. It has been observed that clone yields are usually appreciably lower than those from the respective mother trees at the same ages. Two probable causes of this are the reduction in vigour due to budding and the effect of variable seedling rootstocks. Clone yields are also at a disadvantage compared with mother tree yields because they are the average yields of a number of trees spread over an area in which there must be some soil variation and all the trees of a clone will suffer some degree of competition from neighbours which must be relatively good bearers and therefore make a relatively heavy drain on soil nutrients. Mother tree yields, on the other hand, are from single trees which, on account of the method of selection, are unlikely to be on poor soil, or to have neighbouring trees which are all high yielders. A combination of these may well account for the differences observed, but these are quite commonly large enough to make it worth while investigating the matter further. This, however, cannot be done effectively until clonal rootstocks are available and it has not yet been possible to find time for more than very minor experiments on the propagation of trees on their own roots.

Propagation as seedlings of various kinds

11. *Illegitimate seedling families,* by which is meant families of seedlings raised from open pollinated seeds taken from selected mother trees, would not generally be expected to give yields as good as those obtainable from buddings, especially as they would contain a proportion of predominantly male trees. Nevertheless, it is possible that certain selected mother trees might give rise to relatively high yielding illegitimate seedling progenies and it was considered desirable to investigate the matter, particularly as : (*a*) it would be possible to convert the males in such progenies by budding on the main branches, and, (*b*) some valuable new selections might be found amongst the bearers in these families. The difficulty of carrying out such an investigation comprehensively, is that, as a relatively large number of mother trees and a fair number of seedlings in each family should obviously be used, the land and labour requirements would necessarily be high and hardly justifiable for an investigation probably of less value than other lines of improvement. Consequently, it was thought advisable to collect evidence from some small preliminary experiments before deciding whether to plant such material on a large scale.

12. Four illegitimate seedling families were included in the experiment described in paragraph 4 and it has already been shown that each of these gave significantly lower yields than the corresponding budded clone on *montana* stocks, that all gave lower yields than any clone except the inferior clone ZF9, and that the average yields of the selected and unselected seedlings have never differed significantly. A second experiment was planted in December, 1941, which compares unselected seedlings, four open-pollinated seedling progenies from selected mother trees, and clones of buddings from three of the four mother trees. This is only a small randomized block trial with three-tree plots replicated eight times giving 24 trees in each seedling family or clone, and as it is accommodated in the guard rows of larger trial the blocks are not contiguous. No great precision can therefore be expected. The yields for three seasons and the mean total yields over the same period are shown in Table 7. On the mean total yields all three clones of buddings are better than any of the seedlings selected or otherwise, except that clone N10 is not significantly superior to seedlings of B740. Seedlings of B740 are better than unselected seedlings, but the three other selected seedling progenies are not. On the annual yields, similar results were obtained in 1947 and 1949, but in 1948 there were no significant differences, which is believed to be due to the fact that the hail damage occurring in that season was more severe on the budded than on the seedling plots. If the seedling progeny of B740 be excepted, the two experiments have given the same indications, namely that buddings are better than selected seedlings and the latter do not give significantly higher yields than ordinary unselected seedlings.

TABLE 7. YIELDS, PER TREE LBS. AIR DRY SEED

Age Year	Seedlings					Buddings			Sig. diff.	
	US	B742	B740	ZN21	ZN10	B740	ZN21	ZN10	P=0.05	P=0.05
5	1.5	2.5	2.9	1.6	2.3	4.9	5.1	3.8	1.92	2.52
6	3.4	3.8	4.4	4.6	3.1	6.2	7.5	5.7	not sig	not sig
7	9.7	12.5	16.1	9.7	11.5	23.6	21.0	17.9	8.03	9.53
Total 5–7	14.6	18.8	23.4	15.9	16.9	34.7	33.6	27.4	7.11	9.35

13. In a third small trial open-pollinated seedlings from 11 mother trees have been compared with buddings of the clone ZM8, there being 18 individuals in each family arranged in 18 randomized blocks each of 12 one-tree plots. Naturally, no precise information can be expected from such a small trial but the results, summarized in Table 8, show some points of interest. All the A-type mother trees have given rise exclusively to A-type seedlings, whereas in the progenies of three of the four B-types there is a majority of B-type trees. The figures for percentage of predominantly male seedlings are based on too small a number of trees to be of much value, but two of the progenies are worth noting. The mother tree ZM6, which is predominantly male and was included as a matter of interest, has produced 17 predominantly male seedlings out of 18. The tree KAR was probably self-pollinated, as it produced a fair crop year after year although isolated from other tung trees, and its seedlings show the lowest percentage of males — 22 per cent. When 15 more seedlings of this tree which are growing alongside the experimental area are taken into consideration there are only five of the 33 (approx. 15 per cent.) which are predominantly male. The yields of the ZM8 buddings are not significantly inferior to any of the seedling families in either year, but are only significantly better than the seedlings of ZM6 and B737. This clone is not one of the best and has given much lower yields than clones 10 and 14 in other trials. Three of the seedling families, B733, 14 and 10, are outstanding, being significantly better than six of the others in both seasons. The yields of the bearing trees of the 14 and 10 families are particularly good, but both families have a high proportion of males. Unfortunately this experiment has had to be abandoned owing to a number of deaths from *Armillaria*.

TABLE 8

	Parent Tree												Sig. diff. P=0.05
	ZC2A	ZL22	B733	ZM2	ZO23	ZN24	14	10	B737	KAR	ZM6	ZM8	
Habit of parent..	A	A	B	A	A	A	B	B	A	B	A	A	
Habit of seedlings													
A	18	18	5	18	18	18	6	8	18	14	18	18	
B	—	—	13	—	—	—	12	10	—	4	—	—	
Per cent. of male seedlings ..	56	35	39	24	39	39	61	50	76	22	94	0	
Mean yields, all trees													
age 4 ..	2.9	2.9	6.7	2.8	5.6	4.2	6.4	6.5	1.8	5.1	0.7	6.3	3.3
age 5 ..	6.0	5.1	12.8	5.0	7.8	5.5	9.5	11.8	2.7	9.7	0.7	9.2	5.3
Mean yield, bearers only													
age 4 ..	5.8	4.4	9.8	3.6	8.8	6.7	14.5	11.6	5.4	6.0	8.2		
age 5 ..	13.4	7.6	18.7	6.6	12.0	9.5	22.1	20.3	7.6	12.0	9.1		

14. The results of these three small trials indicate that there is a possibility that the illegitimate seedling progenies of certain mother trees may contain a fair proportion of individuals which come fairly true to the type of the mother tree as regards habit, and that the bearers in such families may give rather good average yields and include some outstanding individuals amongst them. The general indication, however, is that open pollinated seedling progenies will give yields inferior to buddings from the same mother tree. It could therefore hardly pay to plant such seedlings and subsequently to bud the males on the branches ; nor would it be worth while planting them for the sake of the outstanding mother trees which might be found amongst the bearers, as there is much greater likelihood of obtaining valuable new mother trees from legitimate seedling families. These are indications only, and to obtain conclusive information it would be necessary to establish a larger trial in which the seedling progenies of a number of the best mother trees were compared with buddings, but the preliminary results suggest that this is one of the least promising lines of improvement and it is concluded that further work with illegitimate seedling progenies is not at present worth while.

15. "*Clonal seedlings*," derived from seed produced by intercrossing in isolated gardens of buddings, were planted out in December, 1944, in a trial which included plots of the clone ZM8 for comparison. These seedlings contain an average of 28 per cent. of predominantly male trees, as compared with an average of 45 per cent. in ordinary seedling plantations, but on their first crop, borne in 1949, all three "progenies" yielded less than clone ZM8.

16. Fourteen *legitimate seedling families*, totalling 650 trees, were produced by selfing, or crossing between, high yielding mother trees in the hope that amongst the bearing trees in these families there will be some really outstanding individuals which can later be propagated to form new and superior clones of buddings. Several more years' yield records will be needed before selection can be made within these families, but the early yields indicate that some very promising individuals are probably present. A small number of buddings of 20 of the latter have already been planted, so that in a few years' time selection may be based not only on the yield of a single outstanding seedling tree but also on the performance of a few buddings derived from it. None of the existing legitimate seedling families have both parents of the B-type, but in the 1949 flowering season a large number of selfings and crossings of the best B-types were made and the resulting seed will be sown in 1950.

B.—Cultural and Manurial Experiments

Inter-cropping and cover crops

17. The two inter-cropping trials at the Station were dealt with in fair detail in last year's Report and there is little to add to the information given there. The yields for the last two years, and mean total yields for six years, from the older trial are given in Table 9. This experiment compared inter-cropping during the first four rainy seasons with maize, soya beans, velvet beans, dug in annually as a green manure, and a cover crop of *Calapogonium mucunoides*. The beneficial effect of inter-cropping with soya beans, presumably due to a good start being given to the trees by thorough cultivation accompanied by a crop which takes little from the soil, was reflected in the yields each year until 1948, but in 1949 there was no significant difference between the treatments. On mean total yields the soya plots are still significantly better than any of the others, between which there is no difference. This experiment has been concluded and new treatments applied to the plots.

TABLE 9. YIELDS, LBS. AIR DRY HULLED SEED

	Intercrop				Sig. Diffs.	
	Soya	Maize	Velvet bean	Calapog.	P=0.05	P=0.01
1948, per tree, age 7¼	20.8	17.4	16.9	17.7	3.26	4.51
1949, per tree, age 8¼	26.5	24.5	24.0	23.9	not sig	not sig
Total per tree 1944–1949	96.8	77.0	73.0	71.9	11.2	15.5
1949 per acre	1,484	1,372	1,344	1,338		

18. The second experiment compares inter-cropping with soya beans, inter-cropping with a rotation of food crops, a permanent cover crop of *Glycine javanica*, and a treatment in which the trees are merely circle-weeded, and grass between the rows slashed and mulched around the trees with the addition of 2 lbs. per tree, of sulphate of ammonia. This trial, now in its third year, gave a small crop in 1949, but there was no significant difference between treatments. Observations indicate that the grass mulch and sulphate of ammonia have probably so far made up for the lack of cultivation on these plots, but the growth and cropping of the trees in the field as a whole is somewhat below average.

Fertilizers and Manures

19. Fertilizer trials, the earliest of which was started in the 1946–1947 season, have so far only shown a response to nitrogen. Thus, in a factorial trial comparing all combinations of the presence and absence of nitrogen, phosphate and potash, with eight replications and six trees per plot, a significant response to nitrogen applied as 2 lbs. per tree of sulphate of ammonia in December, 1946, and 3 lbs. per tree annually thereafter, was obtained in 1948 and 1949 (Table 10). The increases in both seasons were considerable, very similar in magnitude and highly significant. Since the fertilizer applied in December, 1948, is unlikely to have affected the 1949 crop (set in October, 1948) the increase in yield over the two seasons may be considered to result from a total of 5 lbs. per tree of sulphate of ammonia applied in December, 1946, and December, 1947, and costings on this basis show a profit from the fertilizer of 35s per acre over the two seasons. No significant response to potash or phosphate was obtained in this trial. A similar factorial experiment, in which cattle manure was also included was started under conditions of rather poorer soil and lighter rainfall at Gala Estate in the 1948–49 season. It is highly unlikely that a yield response would have been obtained during the first season, but unfortunately yield records were not obtained as the crop was removed in error before weighing.

TABLE 10

Year	Age	Mean yield lb. dry seed per tree		Sig. diff.		Yield as %O.		Yield lb. per acre	
		O	N	P=0.05	P=0.05	O	N	O	N
1948 ..	4	1.89	2.95	0.13	0.18	100.0	156.1	105.8	165.2
1949 ..	5	7.74	12.07	1.70	2.23	100.0	155.9	433.4	675.9

20. A response to nitrogen has also been evident in the early growth of six small experimental blocks planted in the Vipya in January, 1947. Each block contains five plots of eight trees each in which the following manurial treatments are compared : O—no manure ; D 30 lb. cattle manure per tree; N ½ lb sulphate of ammonia per tree ; NP–as N plus. lb. superphosphate per tree ; NPK—as NP plus ¼ lb. muriate of potash per tree. Sulphate of ammonia applied in 1947 and 1948 resulted in obvious stronger growth and better foliage and the 1949 girth measurements, adjusted by covariance on the girths at time of planting (Table 11) show a significant difference in favour of plots receiving N as compared with O and D plots, but no increase due to phosphate or potash. A factorial experiment in the Vipya comparing all combinations of three levels of nitrogen and phosphate with and without potash was started in January, 1948. The three levels nitrogen were represented by ¼, ½ and ¾ lb. sulphate of ammonia per tree. There appears to have been a significant, but rather small, response to nitrogen, judging from the girth increases shown in Table 12, but the heaviest dose of nitrogen has been less effective than the lightest. Little reliance should be placed on these results until future data has been obtained, as the recording was done by unskilled staff. An experiment comparing three levels of application of nitrogen to mature trees was begun at the Station in the 1948–1949 season but gave no significant results in 1949.

TABLE 11

	O	D	N	NP	NPK	Sig. diff. P=0.05
Mean girth, inches, corrected covariance ..	37.1	38.5	44.1	44.0	44.3	2.2
Above as %O	100.0	103.7	118.8	118.6	119.3	

TABLE 12. GIRTH INCREASES AS % INCREASES IN UNMANURED PLOTS

O	N1	N2	N3	Sig. diff. P=0.05	P=0.01
100.1	117.4	114.5	108.3	4.0	5.4

Organic Manures

21. On one field at the Experimental Station, which had been under cultivation with various crops since 1921, the tung trees made poor growth and it was evident that manuring would be necessary to improve matters. As the three-year old trees were distinctly unthrifty it was thought desirable to apply fairly heavy dressings, but at the same time to take the opportunity of comparing various locally available organic manures, although as no analyses of these were available it was not possible to apply them at rates supplying equivalent amounts of nitrogen or other nutrients. The experiment, which comprises six randomized blocks of five plots each of ten trees, has received the following treatments applied in the month of December in 1946, 1947 and 1948 :—

O No manure.

A Artificial fertilizer mixture of 2 lbs. sulphate of ammonia, 2 lbs. superphosphate and 1 lb. muriate of potash per tree.

FYM Cattle manure at 200 lbs. per tree.

TC Tung press cake at 100 lbs. per tree.

CS Cotton seed at 100 lbs. per tree.

The manures had no effect in 1947, as might be expected in view of the fact that they were not applied until three months after the crop had been set. In Table 13 the yields for 1948 and 1949, after adjustment by covariance on the 1947 yields, are shown as a percentage of those from the control plots. Tung cake and cotton seed have given significant increases over control in both seasons but the increase due to artificials is only significant in 1949, and cattle manure has not produced any significant improvement in yields in either year. The amounts of nitrogen applied per tree per annum in the manures are probably of the order of : artificials, 0.4 lb.; cattle manure, 1.5 lb. ; cotton seed, 2.5 lb.; tung cake 3 lbs. The response to tung cake and cotton seed might therefore be expected to be greater than that to artificials but the effect of cattle manure is disappointing. The trees on all manured plots have greatly improved in growth and appearance since the beginning of the experiment and it should now be possible to apply more equivalent dressings of the various manures.

TABLE 13. YIELDS AS % OF YIELDS FROM UNMANURED PLOTS

Year	O	A	FYM	TC	CS
1948	100.0	125.6	116.3	206.4	154.7
1949	100.0	156.6	117.5	145.8	158.4

C.—Diseases

22. The die-back due to *Botryosphaeria* sp. became an important problem during 1949 and towards the end of the year a programme of work on it, to be undertaken by the Plant Pathologist and the Tung Experimental Station in collaboration, was initiated. Those sections of the work for which the Station is chiefly responsible include : (*a*) A survey of the incidence of the disease in a block of budded trees with a view to obtaining information on the common modes of entry of the pathogen, the extent and rate of progress of infection, clonal susceptibility, and the effect of varying dressings of nitrogen on incidence. (*b*) Two trials on the control of the disease by pruning and spraying treatments. (*c*) Experiments on the treatment and pruning of young buddings aiming at minimizing potential entry points for the disease (*d*) Trial to determine the likelihood of the disease being transmitted during budding.

TEA

Tea Experimental Station. Mlanje

Agricultural Officer in Charge : D. H. Laycock

(Report received 25th April, 1950.)

23. Towards the end of the year a change was made in the staff establishment of the Station. Previously the Agricultural Officer in charge of the Tea Station had also the responsibility of district duties. In November the two duties were separated and allocated to two officers. It is hoped that with the arrival of an officer whose whole time will be devoted to tea much more tea experimental work will be accomplished. One of the first duties of the new officer will be to collate all the past data ; the results will, it is hoped, be then published in full. For that reason the Annual Report for 1949 contains only the briefest details of the experiments in existence and is in fact little more than a list of treatments and results for the cropping season 1948–49.

Down-Pruning of Old Tea

24. This experiment laid down on Ruo Estate in 1944 is designed to test various methods of treating old China Jat tea after down-pruning to 14 inches. There are four treatments replicated in six blocks. After down-pruning all the tea to 14 inches the following four treatments were applied :—

(1) Tip at 27 inches ; cut-across the following year to 22 inches and tip at 26 inches ; prune the next year to 20 inches tipping at 4 inches and thereafter prune 2 inches yearly tipping at 4 inches above the pruning mark.

(2) Tip at 27 inches ; prune-up 1 inch yearly, tipping at 27 inches until the 18 inch prunning level is reached after which still prune-up 1 inch yearly but tip at 4 inches above the pruning level.

(3) Tip at 27 inches ; next year prune at 24 inches and tip at 28 inches ; next prune down 1 inch yearly until the 20 inch level is reached tipping at 4 inches above the pruning level ; thereafter prune up 1 inch yearly until 24 inches is reached tipping at 4 inches above the pruning mark.

(4) Tip at 18 inches ; prune-up 1 inch yearly and tip at 4 inches.

25. The results for the 1948–49 season are given in Table 14 and are expressed in mean yields per acre of lbs. made tea.

TABLE 14

Treatments	(1)	(2)	(3)	(4)	Significant Difference
No. lbs. made tea	741 ..	682 ..	682 ..	683 ..	No. Sig. Diff.

Throughout the period of the experiment there has been no significant differences between treatments.

Tipping Levels of China Jat and influence of Pruning Methods on tipping

26. This experiment was laid down in 1944 to investigate the influence of different tipping levels on the yield of clean-pruned and cut-across pruned China Jat Tea.

27. The experiment was carried out on Ruo Estates and yields were recorded on alternate plucking rounds, the layout being a randomized block of six treatments replicated six times.

Treatments are as follows :—

Treatment (1) Cut-across prune and tip at 2 inches.
Treatment (2) Cut-across prune and tip at 4 inches.
Treatment (3) Cut-across prune and tip at 6 inches.
Treatment (4) Clean-prune and tip at 2 inches.
Treatment (5) Clean-prune and tip at 4 inches.
Treatment (6) Clean-prune and tip at 6 inches.

Results for the 1948–49 season are in Table 15.

TABLE 15

Treatments	(1)	(2)	(3)	(4)	(5)	(6)	*Sig. Diff.*
Lbs. made Tea/acre	497	431	497	529	530	512	No Sig. diff.

Mechanical plucking by Turpen Hand Cropper

28. An exploratory trial of machine versus hand-plucking was carried out on Ruo Estate during the past season.

29. The experiment consisted of twelve blocks each with two treatments :—

(1) Hand-plucking,

(2) Machine-plucking.

30. No previous practical experience of machine-plucking was available at this Station. Throughout the experiment the criterion as to the size of leaf to pluck by machine was taken as being similar to that as when the flush reached the size ready for normal hand fine-plucking. In other words the machine was used as far as possible for fine-plucking.

31. Teething troubles were experienced with the machine and with the labour using the machine. During the first two rounds of machine-plucking, the bushes were levelled off and the leaf and stalk thrown away. After which the leaf was on average fine though mixed with small immature leaf. Selective plucking with the machine was found to be virtually impossible and thus all leaf above the plucking table was cropped. The machine had no bad effect on the appearance of the bush after this trial.

32. The results given in Table 16 were taken during the period 4th May, 1948, to 15 June, 1949, during which there were 22 machine rounds of plucking as against 33 hand rounds of plucking.

TABLE 16

Treatment	*Hand*	*Machine*	*Sig. Diff.*
Lbs/acre made Tea	1,117	867	P=0.01=90 lbs.

33. Hand-plucking therefore gave under the conditions of this experiment significantly more tea per acre than machine plucking.

34. The explanation of reduced yields by the machine is perhaps the lack of selectivity of plucking obtainable. When the machine was used, all the flush was taken including material that was at the optimum stage of growth for the equivalent of fine hand-plucking and young immature growing points, thereby directly reducing the effective weight of crop plucked and also stripping the bush of all immature growing points above the table.

The time taken between plucking rounds on the mechanically-plucked plots is considerably longer than on the hand-plucked plots as can be seen from the number of plucking rounds. There being 22 by machine as against 33 by hand during the same time period.

35. From this trial it is concluded that to use a machine to pluck with the same degree of fineness as that obtained by hand, is not feasible and that crop is lost by using the machine to pluck fine leaf.

Treatment of Young Tea

36. This experiment started in 1942 on the Station was designed to compare various methods of bringing young tea to bearing.

37. The layout is at 6×6 latin square containing the following treatments:—

Treatment (1). At twelve to eighteen months after planting the plants were centred to encourage spread. The bush was then cut level at 14 inches and plucked.

Treatment (2). At nine months onwards the bushes were lightly plucked and at thirty months the bush was pruned for the first time.

Treatment (3). At eighteen months the bush was cut-across to 14 inches and tipped at 27 inches above the pruned level then plucked.

Treatment (4). At eighteen inches the bush was cut-across to 8 inches, tipped at 27 inches, plucked and pruned to 14 inches, at thirty months.

Treatment (5). At eighteen months the bush was cut-across to 16 inches, plucked for two years and then up-pruned two inches yearly.

Treatment (6). The bush was allowed to grow up for thirty months and then pruned at 14 inches and up-pruned 2 inches yearly. Table of results for the 1948–49 season is in Table 17.

TABLE 17

Treatment	(1)	(2)	(3)	(4)	(5)	(6)	*Sig. Diff.*
Lbs/acre made tea	1,161	1,204	1,203	1,139	1,240	1,137	No Sig. Diff.

38. For the last three years single year analyses have shown no differences between the methods.

Spacing of Tea

39. This experiment is designed to test the effect on yield of spacings of tea bushes. It was laid down in 1941 on the Tea Experimental Station and it is a randomized block of four treatments to each block as follows :—

TREATMENTS

(1) Spacing 3½ feet by 3½ feet square.
(2) Spacing 4 feet by 4 feet square.
(3) Spacing 4½ feet by 4½ feet square.
(4) Spacing 5 feet by 5 feet square.

40. Table of results for the past season are in Table 18.

TABLE 18

Treatments	(1)	(2)	(3)	(4)	*Sig. Diff.*
Yield/acre lbs. made tea ..	1,250 ..	1,150 ..	1,115 ..	1,042 ..	No Sig. Diff.

41. No significance is shown. The order of precedence shows that the closer planted bushes have yielded more per acre and the wider the spacing the lower the yield per acre. Throughout this experiment no more than 35 lbs/acre of nitrogen has been given to the treatments.

Investigation of Different Methods of Pruning and extending the Pruning Cycle

42. This experiment on the Station was commenced in 1938 to investigate the effects of different methods and frequency of pruning on Indian Jat tea.

43. The layout is a 6×6 latin square containing the following treatments :—

TREATMENTS

(1) Clean-prune every year.
(2) Cut-across every year.
(3) Cut-across with centre clean out every year.
(4) Clean-prune on a two years' cycle *i.e.*, unpruned 1948, pruned 1949, unpruned 1950 and so on.
(5) Cut-across on a two years' cycle *i.e.*, unpruned 1948, cut-across 1949, unpruned 1950 and so on.
(6) Clean-pruned on a three years' cycle *i.e.*, unpruned 1948 and 1949, clean-pruned 1950 and so on.

(*All pruning cuts are 1 inch above the previous pruning mark.*)

44. The results for the 1948–49 season are in Table 19.

TABLE 19

Treatments	(1)	(2)	(3)	(4)	(5)	(6)	*Sig.*	*Diff.*
Lbs made tea 1 acre	928 ..	641 ..	655 ..	898 ..	665 ..	971 ..	P0.01 ..	P0.05
							140 ..	103

45. The results for the past year again show the superiority of the clean-pruned treatments (1, 4 and 6) which gave significantly higher yields than the cut-across treatments.

46. A full analyses data from the beginning will be submitted as soon as this year's (1949–50) yields are available which will then include information concerning four cycles of treatment (6).

47. Until such time no further comment will be made or conclusions drawn on this most important experiment.

Cultivation Experiment

48. This experiment started in 1941 is designed to compare some manual methods of controlling weeds in tea and the effect of those methods on yields.

49. The layout is a randomized block each block including the seven following treatments :—

TREATMENTS

(1) Hand-weed and weeds left on surface.
(2) Weeds slashed and left on surface.
(3) Weeds hoed and carried off plots.
(4) Weeds hoed and buried.
(5) Weeds hoed and left on surface.
(6) Unweeded.
(7) Leguminous cover crop of *Desmodium* and *Indigofera* plus hand-weeding with weeds carried off plots.

50. The results for the 1948–49 season are in Table 20.

TABLE 20

Treatment	(1)	(2)	(3)	(4)	(5)	(6)	(7)	*Sig. Diff.*
Lbs. made tea 1 acre ..	532 ..	537 ..	582 ..	587	431 ..	582 ..	489 ..	No Sig. Diff.

51. There is again no significant difference. The growth of *Desmodium* and *Indigofera* (7) was very poor owing to the effect of drought in the early part of the year. These plots approximate to clean-weeded plots as the amount of cover crop is so small.

Time of Application of Fertilizer to Tea

52. The objects of this experiment, at the Tea Experimental Station are to investigate the effects of applying fertilizer to tea at various times of the season.

53. The layout is a randomized block including the following treatments :—

TREATMENTS

(1) Whole application of fertilizer applied in the first week of November.
(2) Whole application applied in first week of January.
(3) Half application in the first week of November and half in the first week of January.
(4) Half application first week of November and half in the first week of March.

(*Not more than 35 lbs. nitrogen per acre have been applied at any time during the history of this experiment.*)

54. Results for the 1948–49 season are in Table 21.

TABLE 21

Treatment	(1)	(2)	(3)	(4)	*Sig. Diff.*
Yield per acre lbs. made tea ..	1,144 ..	1,002	1,046 ..	1,093 ..	No Sig. Diff.

55. There was no significant difference in the yield between the treatments which is similar to previous years' results.

Different Level of Sulphate of Ammonia

56. This experiment of randomized block design contains the following treatments :—

TREATMENTS

(1) No Sulphate of Ammonia.
(2) Rate of 170 lbs. Sulphate of Ammonia per acre, equivalent to 35 lbs. nitrogen per acre.
(3) Rate of 255 lbs. of Sulphate of Ammonia per acre, equivalent to 52 lbs. of nitrogen per acre.
(4) Rate of 340 lbs. of Sulphate of Ammonia per acre, equivalent to 70 lbs. of nitrogen per acre.

57. Table 22 contains results for the past season :—

TABLE 22

Treatment	(1)	(2)	(3)	(4)	*Sig. Diff.*
Lbs/acre made tea ..	606 ..	625 ..	615 ..	659 ..	No Sig. Diff.

58. There is no significant difference in yield between treatments. (Plant population by the analysis of covariance has had no significant effect on yield.) It is thought that the failure of this experiment so far to show significant difference in yield is due to die-back which started after pruning in 1948 and was accentuated by the drought in 1949. The population count does not represent the full effect of the die-back as most bushes were not killed outright. Thus debilitated bushes have been included together with healthy bushes in the plot population count.

59. There is conclusive visual evidence of the effect of Sulphate of Ammonia on the growth of wood on the bush. The unmanured bushes are not yet touching between the rows whereas the bushes receiving the highest rate of nitrogen have formed a complete cover and the branches of adjacent bushes are interlacing. The effect of nitrogen at intermediate rates has produced an intermediate effect of wood growth and cover.

Mimosa Tea Experimental Station

60. For some time past the small acreage of tea at Ruo Tea Station has been a limiting factor in the experimental programme, especially so in factory and breeding work. Therefore in 1948 Government acquired 700 acres of unopened tea land near to the established Experimental Station. During the past year clearing and development work proceeded on this new Station.

61. Nurseries have been planted and it is planned to plant the first hundred acres of tea during the 1950–1951 rains.

GENERAL CROPS

Likuni and Lizasadzi Experimental Stations

Senior Agricultural Officer in Charge : S. T. Hoyle

(Reports received 31st March, 1950.)

A.—Fertilizer Experiments

Maize N.P.K. Experiment

62. There were three levels for each fertilizer ; nil, 100 lbs. and 200 lbs. per acre of sulphate of ammonia and superphosphate, and nil, 20 lbs. and 40 lbs. per acre for muriate of potash. The layout was a partially confounded one, blocks of nine plots with three complete replications. Each plot was 55 yards long by 2 yards wide and the maize was spaced 3 feet by 3 feet with three seeds per hole. The whole fertilizer was applied in one application 10 days after planting which was done on 30th November, 1948. The maize was harvested on 16th May, 1949.

TABLE 23

The principal results were :—

YIELD PER ACRE IN LBS. GRAIN

	P0	P1	P2	*Mean*
N0	1,187	1,299	1,255	1,247
N1	1,328	1,530	1,581	1,479
N2	1,385	1,675	1,606	1,556
Mean	1,300	1,501	1,481	1,427

Significant difference between means (P=0.05)=92 lbs. per acre.

63. The effects of nitrogen and phosphate were both highly significant. Neither potash nor any of the interactions approached the level of significance. The application of 100 lbs. per acre of sulphate of ammonia produced a significant increase of 232 lbs. of maize and a further 100 lbs. per acre an increase of 77 lbs. of maize, which was not significant. Superphosphate at 100 lbs. per acre led to an increase of 201 lbs. of maize and a further 100 lbs. of fertilizer actually brought a decrease in yield but the amount was so small that it can be ignored.

64. The general level of yield was very satisfactory in the poor season due to the drought. Broadly speaking the conclusion is that 100 lbs. of fertilizer costing about 25s produced an increase of rather over 200 lbs. of maize. If maize is valued at 1d per lb. this is not an economic proposition.

Maize Residual Phosphate Experiment

65. This experiment was first laid down in 1948 and was repeated this year to test for any residual effect. Superphosphate had been applied at three rates nil, 80 and 240 lbs. per acre. Yields were good and though there was a regular gradation in yield from nil to 240 lbs. per acre, the differences were not significant.

Groundnut Residual Phosphate Experiment

66. This experiment was similar in purpose and rates of application to the maize experiment. Yields were poor owing to the drought and there were no significant differences.

B.—Miscellaneous Experiments

Maize Spacing Trial

67. The ridges in this experiment were all 3 feet apart and three spacings along the ridge were tried all giving the same number of plants per acre. The results were as follows :—

TABLE 24

Spacing	*Yield per acre lbs. Grain*
Holes 1 foot apart 1 seed per hole	1,821
Holes 2 feet apart 2 seed per hole	2,014
Holes 3 feet apart 3 seeds per hole	2,158

Significant difference (P=0.05)=242 lbs. per acre.

68. The results of this experiment confirm that of previous trials conducted elsewhere that 3 feet by 3 feet with three seeds per hole is a good, and probably the best, spacing for maize.

Hybrid Maize Trial

69. Six strains of hybrid maize were sent from Southern Rhodesia and were planted in a trial with two open pollinated varieties, and local maize. Owing to the drought this trial grew exceedingly badly although efforts were made to water it in the field after planting. There was also much damage from termites and the final yields were very poor and the comparison was considered useless.

Maize Cultivation Experiment

70. This was a continuation of the experiment previously reported but the yields were so variable that no significant results were obtained this year.

Bush Eradication Experiment

71. Owing to the importance of finding a reasonably cheap method of eradicating unwanted trees on arable and grazing land an experiment was tried in the use of Agroxone (M.C.P.A.). The land chosen had been partially cleared for grazing and there was a considerable regrowth of *Combretum* sp. and Markamia and other trees. The following treatments were tried :—

1 lb. Agroxone dusted on to	100 sq. yards
2 lbs. Agroxone dusted on to	100 sq. yards
3 lbs. Agroxone dusted on to	100 sq yards
1 lb. Agroxone in 10 gallons water sprayed on	100 sq yards
1 lb. Agroxone in 10 gallons water sprayed on	400 sq. yards.

72. The results were very disappointing as no trees were killed. Various of the leaves of trees and shrubs wilted and some finally died but the trees themselves did not die. Spraying was found more effective than dusting probably because it adhered better to the leaves. Various herbs were killed and the grass was not affected. The trial was carried out on 5th January and the first signs of wilting in the leaves was noticed four days later.

Bean Leaf plucking Experiment

73. It is a common African practice to pluck the growing point and a few young leaves from bean plants and use these for making spinach. At the same time there is a firm belief that this practice increases the yield of beans. A simple experiment on an upright variety of cow-pea was laid out and it was found that plucking the growing point produced a statistically significant reduction in yield of 10.8 per cent.

C.—Tobacco

Flue-Cured Tobacco Fertilizer Experiment at Lisasadzi

74. This experiment was carried out on first year land on the light sandy soil at Lisasadzi Station. The design of the experiment was a three cubed factorial with nitrogen, phosphate and potash at three levels. There were two complete replications and treatments were confounded in sub-blocks of nine plots. The rates of application of ammonium sulphate and double super phosphate were nil, 100 lbs. and 200 lbs. per acre and potash was used at nil, 20 and 40 lbs. per acre.

75. The variety of tobacco was Yellow Mammoth. It was planted out on 26th December, 1948, and the whole of the fertilizer was applied on 4th January, 1949. Topping was done on 1st March and those plants which were not ready for topping at this date were topped 10 days later. The spacing used was 4 feet by 2 feet 3 inches, stands were good and there was no significant difference between treatments for plant number.

76. *Yield.* The yield per acre was good and the weight of wet leaf per acre for the main effects are recorded in Table 25 :—

TABLE 25

N0	465 ..	P0 ..	816 ..	K0 ..	762 lbs.
N1	935 ..	P1 ..	796 ..	K1 ..	834 lbs.
N2	1,033 ..	P2 ..	821 ..	K2 ..	828 lbs.

77. The effect of nitrogen was highly significant (P=0.01). No other treatment effect or interaction approached significance.

78. *Quality.* It had been expected that even if phosphate did not give any increase in yield it might show some effect on quality. None could be detected at all. Each plot after curing was rough graded into five classes. (1) bright leaf with thin body ; (2) bright leaf with heavy body ; (3) semi-bright leaf with light body ; (4) semi-bright with heavy body ; (5) green leaf. The average percentages in the above classes were 30.8, 30.6, 16.4, 7.7 and 14.6. There were no big differences among the treatments from these mean figures except that N0 had 11.3 per cent. green leaf, N1 12.2 and N2 18.1. The leaf was graded not long after curing and it is probable that a good deal of the green colour might have gone out in bulk.

79. Samples of bright leaf from the various plots were inspected by a number of leaf experts and there was no discernable difference between the treatments.

80. *Topping.* When topping was first done on 1st March, 74 per cent. of the total number of plants were ready and the phosphate and potash plots showed no deviation from this figure. In the N0 plots only 38 per cent. were ready, in the N1 plots 78 per cent. and in the N2 plots 83 per cent.

81. *No. of leaves per plant.* The average number of leaves per plant in the experiment was 14.0 and the phosphate and potash plots varied over the small range of 13.8 to 14.1, but the nitrogen plots ranged from 11.7 to 15.9 leaves.

82. Nitrogen was the only fertilizer which had any measurable effect on the tobacco crop on this occasion.

ENTOMOLOGICAL DIVISION

Entomologist in Charge : M. H. Breese

(Report submitted February, 1950.)

83. The unprecendented drought which necessitated the importation of large tonnages of various grains, resulted in a great deal of time being spent in connection with the storage of these and other foodstuffs. Much travelling was done towards this end and there was opportunity for only one general tour round the Protectorate for the inspection of crops.

A.—Crop Pests

84. The drought conditions which prevailed during the early part of the year resulted in outbreaks of certain pests which are normally only of minor importance during this time ; otherwise no serious attacks by insects on any crop were reported.

Cereals

85. The failure of the early planted maize due to drought resulted in there being a succession of plantings between December and mid-February. Under these conditions two and a partial third generation of Stalk Borer (*Busseola fusca* Hmps.) were bred and damage due to this pest was widespread and often severe especially at the higher altitudes where plant infestations of as high as 90 per cent. were recorded.

86. An article outlining the measures to be taken to safeguard both the current and following years' crops was prepared and published in the local Press. A vigorous campaign for the destruction of roots which might harbour over-wintering larvae was conducted, and it is possible to record that at the end of the year stalk borer attack was not greatly manifest in the new crop and there was no indication of there having been a large carry-over.

87. In the Lower River area, borer damage in flood plain (*dimba*) maize was more marked than usual especially during July and August, but death of plants was seldom caused except where borers occurred together with streak disease, the incedence of which was particularly high in *dimba* crops. Three species of borers were involved *viz* :—*Chilo lutulentalis*, Tam (*Pyralidea*)—the most common, and two Noctuid moths—*Leucania* (*Cirphis*) *loreyi* Dup. and *Sesamia calamistis*, Hmps.

88. It has been noted that damage due to *Chilo* increases in severity in drought years (ref. Entomologist's Report 1929 and 1941). During the season under review, only a fraction of the usual Lower River sorghum crop came to maturity, but the generation of moths which bred up in this crop found more than a sufficiency of hosts plants in the greatly increased acreage of *dimba* maize. This increased acreage involved the destruction on a large scale of the common host plants of *Leucania loreyi* namely *Eleusine indica* and *Setaria verticillata* and caused the migration of this pest to the maize crops.

89. Damage to maize by *Sesamia calamistis* was reported from the Limpasa Dambo as well as from the Lower River District.

Coffee

90. Reports of damage by *Antesia variegata*, Thnb. to coffee-growing under *Grevillea robuta shade* were received from a Cholo Estate in July. Examination of the crop revealed that 80 per cent. of the berries showed discoloured areas on the parchment which were due probably to fungi introduced by the bug. It is interesting to record that the crop had been sprayed with a D.D.T. wettable powder in March.

91. Other pests causing slight damage in this crop were the white stem-borer (*Anthores leuconotus* Pasc.), the black stem-borer (*Apate indistincta*, Murray) and *Diryphya* sp.

92. At the Nchenachena Coffee Experimental Station young Robusta Coffee growing under fig and banana shade, showed a high incidence of leaf miner (*Leucoptera coffeela*, Staint.).

93. The soft scale " *Lecanium* " *caudatum*, Green, was also recorded in the small numbers from this crop.

Cotton

94. Cotton-growing was prohibited during the year in an area of 5 miles radius centred on the Makanga Experimental Station. By this means it was hoped to reduce to a very low level, the population of Red Bollworm (*Diparopsis castanea*, Hmps.) within the area and in the following year study the behaviour of early-planted cotton in the virtual absence of bollworm attack. Egg and larvae counts made in control plots outside the area gave an indication of the moth flight during the season.

95. Due to the late planting of cotton in the Lower River District, few plants were in a state conducive to oviposition until mid-May, thus moths of the March/April emergence found little suitable material on which to lay their eggs. The short term generation which developed in the crop during May–June was thus considerably reduced. This fact coupled with the crop in egg-laying which normally occurs in June to August resulted in there being less bollworm damage than is usual in this area.

96. The lateness of the crop together with the dry conditions which prevailed during June had also the effect of preventing the establishment of a large stainer population in the field. In consequence stainer damage was comparatively light.

Legumes

97. *Beans.* The Bean fly (*Melanagromyza phaseoli*, Coq.) and the gall-forming weevils *Alcides leucogrammus*, Er. and *A. dentipes*, F. were the main pest of beans in the Southern Province ; the weevils being particularly prevalent in the Blantyre and Limbe areas during March and early April.

98. In the Ncheu District considerable damage was caused to beans in the early part of the year, by the common Galerucid beetles *Ootheca mutabilis*, Sablb. and *Diacantha conifera*, Farm.

99. *Groundnuts.* At Lisasadzi Experimental Station, death of about 1 per cent. Spanish bunch groundnuts was caused by a ground-inhabiting Coccid of the genue *Ripersis.*

Tea

100. This crop remained remarkably free from the depredations of any insect pest. At one estate in Cholo a few bushes of local jat were completely denuded of leaves by Red Spider (*Tretranychus bioculatus*) in April. Attack by this pest is unusual at this time of the year, but the hot dry weather which prevailed throughout March enabled the pest to multiply at a time when it would normally be quiescent.

Tobacco

101. During the period of severe drought in January an estate near Zomba suffered loss of stand due to the attack of Jullid millepedes. The attack was renewed the following season (Dec.) when up to 40 per cent. of the earlier plantings were destroyed, and in the Chawesa area of tho Zomba District most of the first tobacco planting was lost. In the later plantings loss of stand reached 80 per cent. The incidence of the pest seemed to vary little with soil conditions although attack was most severe in the lighter soils. The pests nibble and remove the outer parts of the stem between 2 and 6 inches below the soil surface, rotting generally follows and causes the death of the plant, although in many cases the stem is completely severed. D.D.T., B.H.C. and Thiophos when used as contact insecticides have little effect on millepedes and hand collecting is still the most effective form of control.

Tung

102. The Coccid *Paraputo ritchieie*, Laing. was reported attacking roots of tung trees both at the Tung Experimental Station, Limbe, and at Mzuzu on the Vipya. In the latter locality, infestation was sufficiently high to cause the death of lateral roots in eighteen-month old nursery stock and to necessitate the removal and destruction of a few trees. Other insecticides not being available the control measure adopted was the removal of soil round the collar of affected trees and the application of a D.D.T. wettable powder spray.

103. Other Coccid pests reported as causing minor damage in Tung were *Icerya purchasi* Mask (Limbe), *I, seychellarum*, Westw. (Mzuzu, Vipya) and *Aspidiotus* sp. (Mzuzu, Vipya.)

104. Termites while not constituting a major pest of tung are often of tremendous nuisance effect especially in young budded trees, the death of which they can cause. On a Cholo Estate trees up to three years old and in bearing, were attacked. The actual loss of trees was between 1 and 2 per cent. but up to 70 per cent. were damaged. The termites seem to be attracted initially to dead bark caused by sunscorch but ringing of the bark extends from 2–3 inches below the soil level to 18 inches or more above. The sudden loss of leaf shade which follows budding or top working renders the tree susceptible to sunscorch and termite attack is usually worst in such trees. The soil on this estate was in rather poor heart and it is unlikely that termite damage would be so extensive were the vigour of the trees greater.

105. Experiments on the control of both sunscorch and termites are in progress.

Miscellaneous

106. The Elegant Grasshopper (*Zonoceros elegans* Thnb.). An experimental campaign against this pest was conducted in the part of the Lower River District bounded by the Ruo, Tangadzi and Shire Rivers. In early stages the grasshopper is gregarious and bands of newly-hatched hoppers generally cluster on small bushes or young food crops especially towards nightfall. Such bands were attacked by means of fire or with 10 per cent. B.H.C., where the food plant was of value. These measures were effective in reducing the number of grasshoppers which would have otherwise spread out in the later stages to attack seedlings of all kinds of crops. A list of oviposition sites favoured by the pest and its preferred wild host plants is being compiled.

Locusts

107. No locusts in any stage of development were reported in the Protectorate during the year.

B.—Storage of Foodstuffs

Grains and Pulses

108. The crop failure which resulted from the drought necessitated the importation and emergency storage of foodstuffs on a scale unprecedented in the Protectorate. Over 13,000 tons of maize alone were stored for varying periods of time in the Central and Southern Provinces.

109. The type of building utilized (cotton sheds and Auction Floors) and the large size of the bulks, made fumigation impossible and it was therefore necessary to devise simple methods of disinfestation which would have the widest application and which would not require qualified and constant supervision.

110. Particular emphasis was laid on the necessity for observing the principles of good storage ; cleanliness and the use of dunnage being insisted upon throughout. The insecticidal treatment standardized was the application of D.D.T., in the form of a wettable powder or dust, to the dunnage and to successive layers of bags as laid down. The wettable powder used contained 20 per cent. D.D.T. and 1 per cent. B.H.C. and was made up with water at the rate of 1 lb. to 4 gallons. Sufficient spray was applied to make the bags just damp to the touch but the hessian did not appear wet. Bags were given time to dry before others were laid on top of them. Dust treatment, because of ease with which it could be carried out, found a wider application and towards the end of the season was substituted for the wet

treatment in the majority of cases. Dust (5 per cent. D.D.T.) was applied by gently tapping a medium-sized tin having holes punched in the base. The rate of application was between 1 and 2 lbs. of dust per hundred 200 lb. bags. The treatment of the surface of stacks with spray or dust at monthly intervals was recommended.

111. It was not possible to assess fully the results of the above treatments but evidence available showed that deterioration was substantially less in treated stacks and food loss in untreated stacks was in some cases as much as 25 per cent. higher than in treated stacks.

Sweet Potatoes

112. A greatly increased acreage of this crop was planted as an emergency measure and it was envisaged that when the main crop was lifted in June and July the question of storing the surplus which could not be consumed at once would arise. Laboratory experiments indicated that it might be possible to dry Sweet-potato slices in tobacco barns and it was found that by this method a satisfactory product could be made quickly and with little trouble. A pamphlet was prepared outlining the method which essentially involved the cutting of tubers into slices not more than half-an-inch thick and drying these on wire mesh trays at a temperature of 140° F. for about 36 hours. Provided that precautions are taken against insect damage and dampness, slices so prepared will keep without deterioration almost indefinitely.

PLANT PATHOLOGY DIVISION

Plant Pathologist in charge : P.O. Wiehe

(Report submitted 1st March, 1950.)

113. The Plant Pathologist assumed duty in the Protectorate on the 21st January, 1949, on transfer from Mauritius and was stationed at Headquarters in Zomba.

114. The work carried out during the year falls into two main parts, namely :

A. An extensive survey of agricultural regions of Nyasaland to determine the occurrence of plant diseases and assess the importance of those affecting economic crops.

B. Special investigations on diseases of the Tung tree (*Aleurites montana*).

A.—Survey of Plant Diseases

115. As a result of the survey work which comprised an aggregate of 81 days spent in the field, 328 diseases previously unrecorded in the Protectorate were observed. A mycological herbarium was started to which 507 accessions were made.

116. In the notes which follow, a brief account of the more important diseases affecting economic crops is given. Diseases of garden plants have been omitted unless they are of special interest. Host plants are arranged alphabetically.

117. It is necessary to point out that many localities could be visited but once during the year. As a consequence it is probable that many diseases have escaped detection.

118. BEAN (PHASEOLUS VULGARIS L.)

1. Leaf spot : *Alternaria* sp. Spots dark brown up to 1 cm. diam., zoned, often coalescing when a large portion of the leaf blade is involved. Causes premature defoliation. Only seen in the Zomba District.

2. Leaf spot : *Isariopsis griseola* Sacc. Common throughout the Protectorate.

3. Mosaic : ? *Phaseolus virus* 1. Not common, causing considerable stunting and leaf distortion. Zomba District.

4. Rust : *Uromyces appendiculatus* (Pers.) Lev. Widely distributed. Varieties cultivated by natives appear resistant. An attack causing severe defoliation was observed on a white seeded, runner variety in the Lilongwe District.

119. BULRUSH MILLET (PENNISETUM TYPHOIDES STAPF AND HUB.)

1. Ear Mildew : *Cladosporium herbarum* (Pers.) Link. Common under conditions of high humidity. Lower Shire District.

2. Leaf spot : *Gloeocerspora sorghi* Bain & Edgert. Occasional, Namweras, causing little damage (see also under Sorghum).

3. Rust : *Puccinia penniseti* Zimm. Widespread. Severe outbreaks have been observed, the damage being aggravated by wind action which lacerates infected leaves. This rust is also common on wild *Pennisetum* spp. The aecidial stage has been collected on *Solanum panduraeforme*. Aecidia developing on egg plant *(S. melongena)* may also belong to the same species.

4. Smut : *Tolysporium penicillariae* Bref. Common, assuming epidemic proportions in one native garden in the Lower Shire District.

120. CASSAVA (MANIHOT UTILISSIMA POHL.)

1. Brown streak : *Manihot virus* 2. The effect of this virus are more serious than those of the mosaic virus and infected plants are frequently killed. The disease does not appear to be as widespread as mosaic. Zomba District.

2. Bacterial Blight : ? *Xanthomonas* sp. Spots angular, translucent with a broad yellow halo, enlarging rapidly and causing a blight. Drops of greyish slimy exudate present on lower surface of spots under damp conditions. Innoculation and reisolation positive. Zomba District.

3. Leaf spot : *Cercospora henningsii* Allesch. Widespread, causing defoliation on some varieties, thereby favouring weed infestation.

4. Mosaic : *Manihot virus* 1. Widespread throughout the Protectorate and causing serious reduction in yields.

121. CITRUS SPP.

1. Anthracnose : *Glomerella cingulata* (Stonem) S. and VS. On lemon, grapefruit and orange, Mlanje.

2. Dieback : *Phoma* sp. in associatoin. On orange, Mlanje.

3. Leaf spot : *Alternaria citri* Ell. and Pierce. Common on lemon and rough lemon, sometimes causing severe defoliation.

4. Mottle leaf : Zinc deficiency. Widespread throughout the Protectorate.

5. Ring blotch : Virus. Spots yellowish-green, translucent, coalescing, forming a wavy pattern on leaves of affected trees. On lemon and grapefruits, Neno, Namweras and Zomba District.

122. COCONUT (COCOS NUCIFERA LINN.)

1. Leaf spot : *Pestalotia palmarum*, Cooke. Common but not serious, Fort Johnston.

123. COFFEE (COFFEA SPP.)

1. Anthracnose : *Colletotrichum coffeanum* Noack. Common on Arabian coffee at Nchenachena ; causing a significant amount of die-back.

2. Leaf spot : *Cercospora coffeicola* Berk. & Br. Spots dark brown with sometimes an ashy-grey centre and a conspicuous broad yellow halo. Tufts of conidia emerge in concentric rings from the lower surface of the spots. Common, causing some defoliation during damp weather. Zomba, Cholo, Nchenachena, Neno.

3. Root rot : associated with *Rhizoctonia* sp., Nchenachena.

4. Rust : *Hemileia vastatrix* Berk. & Br. Widely distributed on Arabian coffee.

124. COTTON (GOSSYPIUM SPP.)

1. Angular Leaf spot, Black Arm : *Xanthomonas malvacearum* (F. Sm.) Dowson. Leaf symptoms have been observed at the Empire Cotton Growing Corporation Station, Salima ; Fort Johnston and Lower Shire Districts. In several gardens in the Fort Johnston area the disease was more serious causing locally a high proportion of dead stems. Pathogenecity of the organism was confirmed by isolation from dying stems and innoculations.

2. Collar rot : *Rhizoctonia* sp. Localized distribution. The effects of the disease are aggravated by subsequent termite attacks which ring the plant at the collar.

3. Leaf spot : *Cercospora gossypina* Cooke. Common but not serious, Lower Shire.

4. Mildew : *Ramularia areola* Atk. Widely distributed, but of minor importance.

125. COWPEA (VIGNA UNGUICULATA (L) WALP.)

1. Mildew : *Oidium* sp. Severe attacks have been observed causing extensive defoliation. Zomba.

2. Mosaic : *Virus*. White to greenish-white mottling accompanied by slight puckering, necrotic spots and thickening of lateral veins. Mwanza District.

3. Rust : *Uromcyces vignae* Barcl. Occasional, not serious, Lower Shire.

126. FINGER MILLET (ELEUSINE CORACANA GOERTN.)

1. Leaf spot, Blight : *Gloeocercospora sp.* Widely distributed, causing severe blight.

127. FOREST TREES

1. *Armillaria mellea* (Vahl.) Fr. The host range of this fungus in Nyasaland was extended by the following new records : on *Araucaria angustifolia* in forest plantations, Zomba Plateau ; *Callitris* sp. grown as a windbreak, Nchenachena ; wattle (*Acacia mollisima* Willd.) in experimental plots, Vipya.

2. *Botryosphaeria ribis* (Fr.) Gr. & Dug. is the cause of a serious disease of *Grevillea robusta* Cunn. planted as a shade tree in tea gardens. Large branches die-back, and young trees may be killed. The disease is associated with a profuse gummy exudate of affected parts.

3. *Diplodia pinea* (Desm.) Kickx. on *Pinus montezumae* and *P. radiata* in Forest plantations at Limbe.

128. GRAM (CICER ARIETINUM LINN.)

1. Blight : ? *Ascochyta* sp. Plants turn yellow, wilt and die as a result of root decay and infection of the lower portion of the stem. Disease widespread in several native gardens, Chiradzulu District.

129. GREEN GRAM (PHASEOLUS MUNGO LINN.)

1. Mildew : *Oidium* sp. Causing severe defoliation, and reduction in size of pods. Lower Shire.

130. GROUNDNUT (ARACHIS HYPOGEA LINN.)

1. Leaf spot : *Cercospora personata* (B & C.) Ell. & Ev. Widespread, but plants usually attacked towards the end of their life cycle.

2. Rosette : *Arachis virus* 1. Widespread, causing significant yield reduction.

3. Wilt : *Xanthomonas solanacearum* (E. F. Sm.) Dowson. Few plants affected, Salima.

131. HYACINTH BEAN (DOLICHOS LABLAB LINN.)

1. Leaf Spot : *Cercospora canescens* Ell. & Mart. of minor importance. Mwanza District.

2. Mosaic : Virus. Mottling of foliage accompanied by distortion of leaves and stunting of plants, Mwanza District.

132. MAIZE (ZEA MAYS L.).

1. Foot rot : Associated with *Helminthosporium* sp. Pathogenecity of organism not determined. Zomba District.

2. Leaf spot and Blight : *Helminthosporium turcicum* Pass. Occurs wherever maize is grown in the Protectorate. The disease is generally not serious. Under abnormally wet conditions, however, the spots elongate rapidly causing a blight of the foliage which favours extensive damage by wind.

3. Rust : *Puccinia sorghi* Schw. Widespread, of secondary importance under field conditions. Sweet corn varieties, however, are more susceptible and may suffer heavy damage from the disease.

4. Smut : *Sphacelotheca reiliana* (Kuhn.) Clint. The same species causing head smut of Sorghum. Widespread but generally of low incidence when present.

5. Streak : *Zea Virus* 2. The most serious disease of maize in the Protectorate, often causing considerable stunting and consequent failure of cobs. In regions where several crops of maize are grown in succession (*dimba* gardens of the Lake-shore, flood plains of the Shire, *dambos* at all altitudes), the incidence of streak becomes progressively more severe, probably because of an increase in both infective material and vector population.

133. PIGEON PEA (CAJANUS INDICUS SPRENGL.)

1. Leaf spot : *Cercospora cajani* P. Henn. Small densely scattered brown spots causing defoliation of new foliage, Mlanje.

2. Mildew : *Leveillula taurica* (Lev.) Arn. Widely distributed. May cause blight of young shoots under damp conditions.

3. Wilt : *Fusarium* sp. in association. This disease was only observed in the Lower Shire. Pathogenecity of the organism was not determined.

134. POTATO (SOLANUM TUBEROSUM LINN.)

1. Early Blight : *Alternaria solani* (Ell. & Mont.) Jones & Grout. Widespread, occurring chiefly towards the end of the growing season. Widespread, Zomba and Dedza Districts. Severe attack observed in the Cholo area.

2. Virus diseases : Symptoms resembling infection with the following viruses : mosaic (*Solanum virus* 1), leaf roll (*Solanum virus* 14).

3. Wilt : *Xanthomonas solanacearum* (E.F.Sm.) Dowson. In vegetable garden at Zomba where egg plants and tomato were also infected.

135. RICE (ORYZA SATIVA LINN.)

1. Blast : *Piricularia oryzae* Cav. Common and causing significant damage on hill rice at Kasupe (Upper Shire).

2. Leaf spot : *Helminthosporium* sp. in association, Fort Johnston.

3. Spot on glumes : *Sporidesmium bakeri* Sydow. Causing premature drop of grains. Mpemba.

136. SIM SIM (SESAMUM INDICUM LINN.)

1. Mildew : *Sphaerotheca fuligena* (Schlecht.) Poll. Causing blight of young shoots, Mpemba.

2. Wilt : *Fusarium oxysporum* Snyd. and Hans. A serious disease killing many plants in random patches. Mpemba, Lower Shire at Mbanji.

137. SORGHUM (SORGHUM VULGARE PERS.)

1. Leaf spot : *Gloeocercospora sorghi* Bain & Edgert. Widely distributed. Affected leaves turn purple, severe spotting and blight may occur.

2. Mildew on Inflorescence : *Cladosporium herbarum* (Pers.) Link. Occasional in damp weather, Zomba District.

3. Rust : *Puccinia purpurea* Cooke. Widely distributed but of secondary importance.

4. Covered smut : *Sphacelotheca sorghi* (Link) Clint. Widely distributed and causing significant yield reduction.

5. Head Smut : *Sphacelotheca reiliana* (Kuhn) Clint. Widely distributed and locally common causing much distortion of the flower head. The same smut attacks maize and was also collected on the grass *Cleistachne sorghoides* Benth.

6. Loose smut : *Sphacelotheca cruenta* (Kuhn) Potter. Widely distributed. Generally very common on ratoon sorghum. Also attacks *Sorghum verticilliflorum* (Steud.) Stapf.

7. Streak : ? *Virus*. Common symptoms resemble maize streak at first, but on older leaves necrosis of tissues follow, producing elongated dark-brown stripes along which the blade is easily torn.

138. SUGAR CANE (SACCHARUM SPP.)

1. Brown spot : *Cercospora longipies* Butl. Heavy attack on P.O.J. varieties, Tea Experimental Station, Mlanje.

2. Mosaic : Virus. Three types of symptoms have been observed ; (*a*) mottling of foilage, (*b*) heart rot, (*c*) yellow stripe. Zomba District.

3. Red spot of leaf sheath : *Cercospora vaginae* Kruger. Common, of secondary importance.

4. Ring spot : *Leptosphaeria sacchari* Breda de Haan. Common but the spots occur on old leaves.

5. Streak : Zea Virus 2. Common on Uba variety. The following grasses occurring in the vicinity of infected sugar cane showed symptoms of streak associated with extreme stunting in several cases : *Digitaria horizontalis* Willd., *Hyparrehenia dissoluta* C.E. Hub., *Panicum trichocladum* Hack., *Rhynchelytrum repens* C.E. Hub.

139. SWEET POTATO (IPOMEA BATATAS (L) LAM.)

1. Leaf Spot : *Curvularia geniculata* (Tracy & Earle) Boediger. Causing blight of foliage. Lower Shire at Chiromo.

2. Mosaic : Virus. The symptoms vary on different varieties. Briefly, the following features are common : bronzing of young leaves marked mottling, reduction in size of blade, distortion, puckering and shortening of internodes. The disease was observed in several districts ; Zomba, Fort Johnston, Lower Shire (Tengani) and Salima. Few plants only were affected. Attempts at transmitting the virus mechanically were negative.

140. TEA (THEA SINENSIS LINN.)

No disease previously unrecorded in Nyasaland were observed. Of the diseases of major importance *Armillaria* root rot was reported on several occasions but the systematic ring-barking of forest trees before gardens are established has significantly reduced the incidence of root rot. An outbreak of violet root disease ? *Helicobasidium* sp. on seedlings was studied at Mlanje.

141. TOBACCO (NICOTIANA TABACUM L.)

The following list of tobacco diseases is compiled from various sources, (1), (2), (3)). Those marked with an asterisk were observed in 1949. Diseases previously unrecorded from the Protectorate are marked with a dagger.

1. Angular leaf spot : *Pseudomonas angulata* (F. & M.) Staff, reported to have caused losses of up to 60 per cent. in the past.

2. Black shank : *Phytophthora parasitica* Dast. emend Ashby. Not common.

3. Black stem rot : *Pythium aphanidermatum.* (Eds.) Fitz.

†4. Brown leaf spot : *Alternaria longipes* (Ell. & Ev.) Tisd. & Wak. Mild attacks in the Lilongwe and Zomba Districts.

5. Deficiency Diseases : The following deficiencies have been reported :—

(*a*) Magnesium (sand drown)

(*b*) Phosphate

(*c*) Potassium

*6. Drought spotting : Unfavourable water relationship between plant and soil. Decay of affected tissues is often hastened through attacks by *Alternaria tenuis* Nees.

*7. Frog eye : *Cercospora nicotiana* Ell & Everh. Widespread.

8. Granville Wilt : *Xanthomonas solanacaerum* (E.F.Sm.) Dowson.

9. ? Kromnek, Tomato spotted wilt : *Lycopersicum virus* 3. Smee (2) records this serious disease of tobacco as probably occurring in Nyasaland. Symptoms resembling infection with this virus were observed on tomato and antirrhinum during the year, but were not seen on tobacco.

*10. Leaf curl : Nicotiana Virus 10. Widespread but of low incidence.

11. Leaf spot : *Pleosphaerulina ? argentinensis* Speg.

*12. Mosaic. Virus : Probably the commonest disease of tobacco in Nyasaland. Three forms can be readily distinguished :—

(*a*) typical mottling.

†(*b*)‡ mosaic scorch in which large areas of the lamina dry off and decay. A ring pattern of tissues showing various stages of necrosis can be observed. *Alternaria tenuis* Nees often develops on the scorched areas. Lilongwe District.

†(*c*)‡ Spot necrosis, in which small white spots (up to 3 mm. diam.) develop chiefly on older leaves of mosaic infected plants. Lilongwe and Zomba Districts.

*13. Powdery mildew : *Erysiphe cichoracearum.* DC. Widespread.

†14. Red rust : Physiological. According to Hopkins (Diseases of Tobacco in Southern Rhodesia, 1931) the disease is caused by unbalanced and excess Nitrogen. Lilongwe and Zomba Districts.

---

‡ I am indebted to Dr. J. C. Hopkins for the diagnosis of these forms of mosaic.

(1) Ann. Reports Department of Agriculture, Nyasaland, 1926–1948.

(2) Butler, E. J. (1928) Report on some diseases of tea and tobacco. Government Printer, Zomba.

(3) Smee, C. (1945) Notes on Plant Virus disease with special reference to tobacco. Nyasaland Agricultural Quarterly Journal, **5**, 73–89.

15. Rosette : virus.

16. Stem rot diseases : *Rhizoctonia solani* Kuehn. *Sclerotium rolfsii* Sacc., *Bacillus caratovorus* L. R. Jones.

17. Wild fire : *Pseudomonas tabaci.* (Wolf. & Frost) Staff.

142. TUNG (ALEURITES MONTANA FORSK.)

1. Collar rot *Armillaria mellea* (Vahl.) Fr. One of the most serious diseases of *A. montana* under local conditions. Ring-barking of forest trees in areas planted under tung has reduced the incidence of the disease. *Armillaria* infection is still common, however, and once the fungus is established in an orchard, it is found that the disease spreads from tree to tree in spite of trenching.

2. Collar rot of seedlings : *Rhizoctonia ? solani* Kuhn. Occasional in nursery beds, affecting local patches of seedlings.

3. Deficiency Diseases. Zinc deficiency is widespread but corrective applications of Zinc sulphate to the soil or as a spray with lime have been in use for several years. Deficiencies of other elements are probably common as is evidenced by certain types of leaf symptoms.

4. Die-back. *Botryospaeria ? ribis* Gr. and Dug. Widespread and observed in all the Tung-growing areas of the Protectorate. This disease is dealt with separately in Section B.

5. Die-back. Various fungi in association with dying twigs.

(*a*) *Fusarium lateritium* Nees. Not observed recently. Records in Annual Report, Department of Agriculture, Nyasaland, 1940.

(*b*) *Glomerella cingulata* (Stonem.) S. & vS. Occasional.

(*c*) *Pestalotia* sp. Probably a weak parasite.

6. Gall. Cause unknown. Only one case observed in an orchard at Zomba. Large galls measuring up to 18 inches × 12 inches occur at the point of branching of most stems. Branches break off readily at their point of union with the gall. Tree misshaped with small crown.

7. Leaf spot : At least four distinct types of leaf spotting which appear to be pathogenic were studied, but the identity of the organisms concerned has not been confirmed yet.

8. Root disease : *Rhizoctonia lamellifera* (Small) in association. It is doubtful if this pathogen is the primary cause of this disease which assumed epidemic proportions on one estate of the Cholo District. The disease may be related to unfavourable environmental conditions or *Rhizoctonia* may develop on roots already killed by another factor.

9. *Sunscorch.* Common on young budded plants and top-worked trees. The disease occurs during hot dry weather when shade of the stock plants is removed by cutting back to force out the scion buds. Parasitic fungi, mostly *Botryosphaeria* sp. and *Botryodiplodia theobromae* Pat. gain entry into the stem through the portion of bark killed off by the sun. (W.N.W. aspect) and death of the plant often ensues. Trees affected by sunscorch are also very susceptible to white ant attacks.

10. Suspected Virus diseases. Symptoms suggestive of virus infections have been observed on several occasions in different localities. Budding experiments are in progress to elucidate the cause of these diseases.

143. WHEAT (TRITICUM SPP.)

1. Foot rot of seedling plants : *Helminthosporium* sp. in association. Local attacks involving death of plants in small groups of up to 20 individuals. Mpemba.

2. Powdery mildew : *Erysiphe graminis* dc. Only observed in the Northern Province (Nchenachena) and reducing markedly vigour of plants.

3. Rusts: (*a*) *Puccinia graminis* Pers. Recorded in Annual Report, Department of Agriculture, Nyasaland, 1932, but not seen recently.

(*b*) *Puccinia triticina* Erikss. Neno Hills, Vipya, causing significant damage.

B.—Investigations on Diseases of the Tung Tree (*Aleurites montana*)

144. Diseases affecting *Aleurites montana* in Nyasaland have been listed in the first part of this Report. Although some experimental work was carried out on several diseases (Sunscorch, *Armillaria* collar rot, Root disease), greater attention was devoted to die-back, and the results of observations made so far are summarized below. The writer is indebted to the Senior Agricultural Officer and Agricultural Officer, Tung Station, for their help in many ways in connection with these studies.

Botryosphaeria Die-back

145. The increasing incidence of dead branches on otherwise healthy tung trees had already caused some concern prior to the arrival of the Plant Pathologist, who was requested to investigate this disease shortly after assuming duty.

Cause of the disease and its distribution

146. A branch and twig canker associated with a species of *Dothiorella* was reported from Nyasaland in 1940 (Ann. Rep., Dept. Agric., 1940). It is probable that the disease under reference and die-back are caused by the same organism. *Botryosphaeria ? ribis.* Gr. and Dug. was repeatedly isolated from diseased tissues. Pathogenacity of the fungus was established by innoculations in seedlings and adult trees followed by reisolations. Apparently the same species was isolated from die-back and branch canker of apple, avocado pear, *Grevillea robusta.* Innoculations using these different isolates on *Aleurites montana* produced similar symptoms to controls innoculated with the species attacking tung trees. The disease is widespread. It was observed in all localities where tung is grown, causing a blight of seedlings and young budded plants or a die-back of twigs and main lateral branches on adult trees or again a blight of the fruit clusters.

Symptoms of the disease

147. The symptoms of the disease vary according to the organs attacked :

(i) on seedlings and young budded plants the younger leaves wilt first, the apex of the shoot shrivels and dries out followed by death of the plant. In longitudinal section the tissues are discoloured brown.

(ii) Die-back of twigs on adult trees should not be confused with normal suppression of small branches which always occurs inside the crown of any normal tree.

Twigs attacked by *Botryosphaeria* dry out along a distance of from 1 to 2 feet from the apex.

Under unfavourable environmental conditions, this form of the disease may be severe producing a stag's head effect.

(iii) Probably the most serious form of die-back involves large branches. The leaves wilt suddenly due either to a rapid spread of the fungus killing off the stem tissues or due to original infection having taken place lower down the stem, thereby stopping water conduction to the leaves. Internally infected wood is discoloured brown, distinct brown streaks extend into healthy tissues. The pith rots away and is always attacked in advance of woody tissues. On stems where the advance of the fungus has been arrested a distinct rim of callus tissue marks the zone of separation between dead wood and living tissues. Internal examination of such stems however, reveals the presence of discoloured vascular bundles in apparently healthy stem. Such infected strands have yielded *Botryosphaeria* sp. in culture thereby indicating that the pathogen can remain in a latent condition in the tissues once a branch has been infected.

(iv) The fungus may attack individual fruits which turn black and drop, or it may cause a blight of the whole fruit cluster due to local infection as opposed to that which results from stem infection.

Mode of infection

148. Wilted branches are frequently seen after the trees burst into leaves, *i.e.*, from about the month of October. The incidence of the disease appears then to diminish gradually as the season advances. Fruiting bodies of the fungus develop from one to three months after a branch has been killed, when the black stromatic structures break through the dead bark. On artificially innoculated stem, however, the stroma may appear about a fortnight after innoculation. Infection takes place through wounds or the fungus penetrates a healthy shoot through the apical bud, the withering male inflorescence, the previous season's fruit stalk or the immature fruit. Young budded plants are easily infected either through the pruning cut where the stock has been removed or through the dying stock snag.

Importance of the disease

149. The present losses caused by *Botryosphaeria* sp. in nurseries and orchards are significantly high, and justify in themselves an intensive study of the disease with a view to discover the most efficient control measures.

150. As an illustration of the present status of die-back the following data obtained by the Agricultural Officer, Tung Experimental Station, are of interest, these observations were made on a nine year-old plantation of 356 trees. Individual records for each tree included : number of infected branches, mode of infection and extent of penetration of the pathogen into the stem.

(i) Incidence of the Disease in a Tung Orchard :

Total number of plants in field	356 (9 year old)
Number of plants affected by *Botryosphaeria*	191
Per cent. infected trees	53.6

(ii) Mean Number of Affected Shoots/Tree :

Habit type A	1.8
Habit type B	28.0

(iii) Severity of the Disease :

Mean total length of shoot dying as a result of *Botryosphaeria* infection.

Habit type A	13.7 inches per tree
Habit type B	288.9 inches per tree.

(iv) *Penetration of fungus.* Resulting from one season's infection it was found that the fungus had penetrated on the average nearly to three-year-old wood. In one case the fungus had reached the trunk.

151. The full results of this survey and other experimental work will be reported elsewhere, but it is important to point out at this stage that there appears to be marked varietal susceptibility to *Botryosphaeria* infection. There is also evidence that male trees are less susceptible to the disease than bearers.

Control Measures

152. In view of the importance of this disease to a promising and rapidly expanding industry, notes on *Botryosphaeria* die-back were prepared by the Senior Agricultural Officer, Tung Station, and the writer and circulated to all Tung growers in the Protectorate. Emphasis was laid on control measures which are briefly summarized herewith :

(i) Systematic inspection of orchards to detect diseased branches.

(ii) Pruning off diseased wood taking care to cut well into healthy tissues.

(iii) Protecting the cut surfaces with a fungicidal paste.

(iv) Burning all pruned branches.

(v) Use of fungicidal paste after cutting back the stock from a budded plant.

Experimental work in progress

153. In collaboration with the Senior Agricultural Officer, Tung Station, a programme of investigations on tung die-back was started during the year. These experiments include :

(i) Test of various fungicidal pastes to protect wounds.

(ii) Mode of infection of the pathogen.

(iii) Clonal susceptibility to the disease.

(iv) Seasonal variation in incidence of die-back.

(v) Spread of disease within a tree.

(vi) Control of disease in nurseries.

C.—General

154. The following legislation connected with plant disease was passed during the year :

(*a*) General Notice 89 concerning importation of tomato seeds from countries where Bacterial Canker is known to exist.

(*b*) General Notice 242 preventing importation of sunflower seed from Peru and Argentina.

155. The writer is indebted to the Director of the Commonwealth Mycological Institute and his Staff and to the Director of Kew Herbarium for their help in the identification of pathogens and host plants.

156. In the absence of a laboratory the Plant Pathologist worked in part of the Entomologist's laboratory to whom he is most grateful for many facilities.

E. Lawrence
Acting Director of Agriculture